DWR/Reclamation Draft Response Plan

DWR/Reclamation Public Workshop

On the Draft Response Plan to Address Issues Raised

In the Calsim II Review Report (December 2003)

April 9, 2004

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United States Bureau of Reclamation

Topics to be Covered

1. Response Process & Overview of Draft Response Plan
2. Goals, Philosophy, and Priorities
3. Major Response Issues
4. Hydrology Development and Ground Water Modeling
5. Summary and Conclusions

1. Response Process
& Overview of Draft Response Plan

by T. Kadir

Purpose of Draft Response Plan (DRP)

- Clarifies issues raised by the Peer Review
- Outlines priorities of development by DWR/Reclamation
- Addresses current and future development work

Overview of Draft Response Plan

- Summary of Peer Review Comments & Responses (Table -1)
  - Conceptual level
  - Implementation level
- Address Peer Review Comments
  - Conceptual level (geographic scope, groundwater, hydropower, ……, hydrologic uncertainty, documentation)
  - Implementation level (numerical approach, data, data management, software, administrative)
  - Model evaluation
- Development of Priorities (also Table-2)
  - Current development work
  - Short term model development
  - Long term model development

2. Goals, Philosophy, Priorities

by L. Brekke

Goals of Calsim II Development

- Develop, maintain, and advocate Calsim II as the best representation of the SWP & CVP for planning and management studies.
- Serve organizations interested in CVP/SWP management.
  - Develop/ maintain best available technical tools for planning and management studies.

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Philosophy of Response

- Steering Factors: Calsim II Goals
- First Level Elements
  - Maintain trust
  - Quality assurance
- Second Level Elements
  - Obvious and feasible enhancements
  - Serve evolving needs of the user community

Drafting Priorities: Perspective A

- (i.e.) Section 3 of Draft Report
  - Reactive to what was heard during Peer Review
  - Not considering what's been initiated
  - Not considering staff/resource limitations

Drafting Priorities: Perspective B

- (i.e.) Table 2 of Draft Report
  - Considers what has already been initiated
  - Considers foreseeable resources
  - Stakeholder partnerships can be a factor in scheduling and prioritization

Priority Categories given Perspective A:
(Initiated Projects)

I. Maintain Credibility/Trust
   a. Uncertainty & Sensitivity Analyses
   b. Documentation Enhancement
   c. Formalize Training Schedule & User Group

II. Hydrology Enhancement
   a. Sacramento Valley (near-, long-term goals)
   b. West Side San Joaquin

Priority Categories given Perspective A:
(Initiated Projects)

III. Software Development: Part 1

a. Version Control
b. (Meta) Data Control
c. Error Checking
d. Solver Enhancement
e. Graphical Network Builder

Priority Categories given Perspective A:
(Initiated Projects)

Calsim II Module Enhancements

a. Operations Foresight Module (i.e. CAM, simulating multiple periods into the future to steer simulated decisions in the present month)

b. Water Quality Modules
   1. SWP/MWD-related facilities
   2. San Joaquin River, mass balance relation between Westside Drainage and Vernalis

Priority Categories given Perspective A:
(Initiated Projects)

V. Software Development: Part 2

a. Enabled Modularity (Layers)

b. Runtime Reduction of Calsim II

   1. More efficient data handling
   2. Elimination of repetitive SJ subsystem simulation
   3. Exploration of inefficiently coded constraints

c. Ability to link existing MILP problem to non-linear simulation extensions

   1. (e.g. daily time-step simulation w/ water routing)

Priority Categories given Perspective A:
(Initiated Projects)

VI. Application/Software Extensions

a. Modular application of Calsim II in updated Calsim software (Calsim 2.0)

b. Enhanced representation of water management schemes

1. Demand management
2. Supply Augmentation (e.g. conjunctive use)
3. Expanded Geographic Domain

3. Major Response Issues

a. Uncertainty and Sensitivity Analyses, Documentation Plan, and Training

by L. Brekke

Uncertainty and Sensitivity Analyses

- Sensitivity Analysis
  - Purpose: measure model response to input changes
  - Product: suggests model areas where high level of confidence on inputs is critical
  - Preliminary analysis has been initiated (DWR)

Uncertainty and Sensitivity Analyses (cont.)

- Uncertainty Analysis
  - Establish inputs confidence
  - Propogate inputs confidence to results confidence
  - Analysis concept is being formulated.

Documentation Plan: Goals

- Fundamentals
  - Software and CVP/SWP application
- Assumptions
- Logic/data description
- Sensitivity and limitations

Documentation Plan: Future Strategy

- Formalize documentation protocol
- Develop convenient maintenance system
- Multiple media products
  - Outside Calsim software
    - Manual
    - Help files
  - Inside Calsim software
    - Code statement documentation protocol

Documentation Plan: Core Management System

Central Database Archive

- Documentation linked to code
- Meta-Information
  - Variables, lookup tables and time-series
- Data confidence record
- Historical log
- Advanced query options

Documentation Plan: Key Features

- Actual practice vs. model implementation
- Descriptions at tiered levels of detail
- Linked source references
- Linked graphics

Training

- Provide training workshops on a regular basis
- In the past, the training workshops have been very well attended
- CWEMF has been very supportive and instrumental in sponsoring the training workshops

b. Model Evaluation

i. General Concepts

by L. Brekke

Classical Concept

- Calibrate
  - Measure model results against observed data
  - Adjust model parameters to improve the fit
- Validate
  - Measure model results against observed data
  - Use results/data cases outside calibration period

Concept applied to CALSIM II

- Peer Review:
  - Requests for calibration/validation
- Work to Date:
  - DWR, "Simulation of Historical SWP/CVP Operations" (2003)
    - Reconstructed land use, demands, regulations, but not <u>operational philosophy</u>
- Future Work:
  - Implementing approaches for evaluating (a) Operational Philosophies, (b) Physical Representations

ii. Operational Rules

by L. Brekke

Evaluating Operational Philosophies

- Difficult to classically calibrate/validate
- Current Approach:
  - Subjective evaluation by CVP/SWP Operators:
  - Context: "Level" Studies development
    - OCAP
    - Oroville FERC relicensing
  - "How would CVO & OCO operate given the simulation assumptions?"

Evaluating Operational Philosophies

- Current Approach:
  - Motivating Factors:
    - limited information <u>explaining</u> historical operations
    - Interrupted corporate knowledge
  - Perceived Benefits:
    - Adaptive to a "moving target" (i.e. operations philosophy)
    - Maintains operators' level of confidence in Calsim II
    - Requires significantly less resources than historical reconstructions

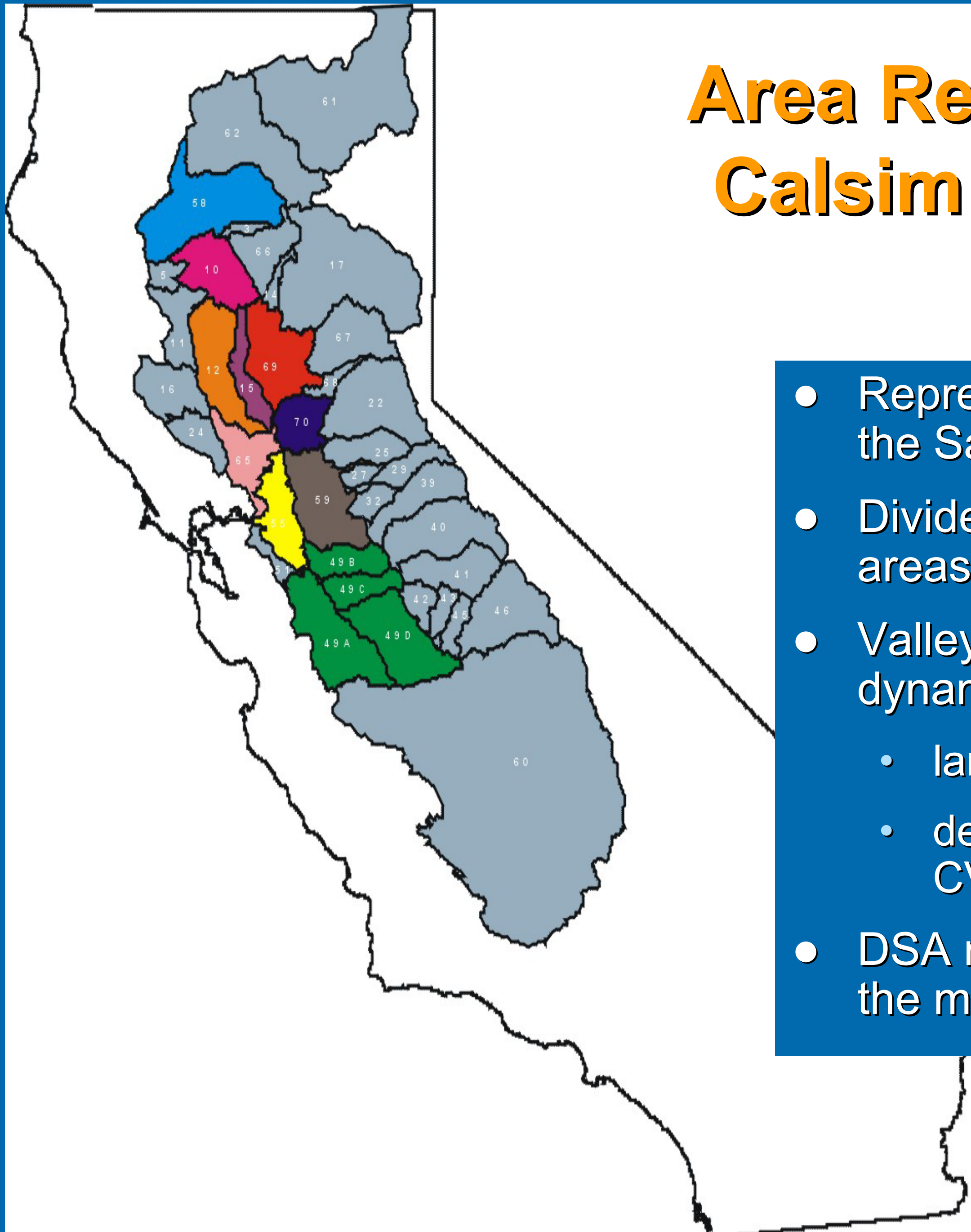
iii. Calsim II Hydrology Evaluation

by A. Draper

Calsim II Hydrology

- Many of the criticisms of Calsim II relate to hydrology
- Broad term that includes
  - the conceptual (node-link) model of the Central Valley,
  - the calculation of water supply and demand inputs
  - water use parameters (efficiencies, losses, etc.)
  - representation of groundwater
- Debate over
  - need for testing, calibration and validation of hydrology
  - efficacy of comparing Calsim II results to historical data

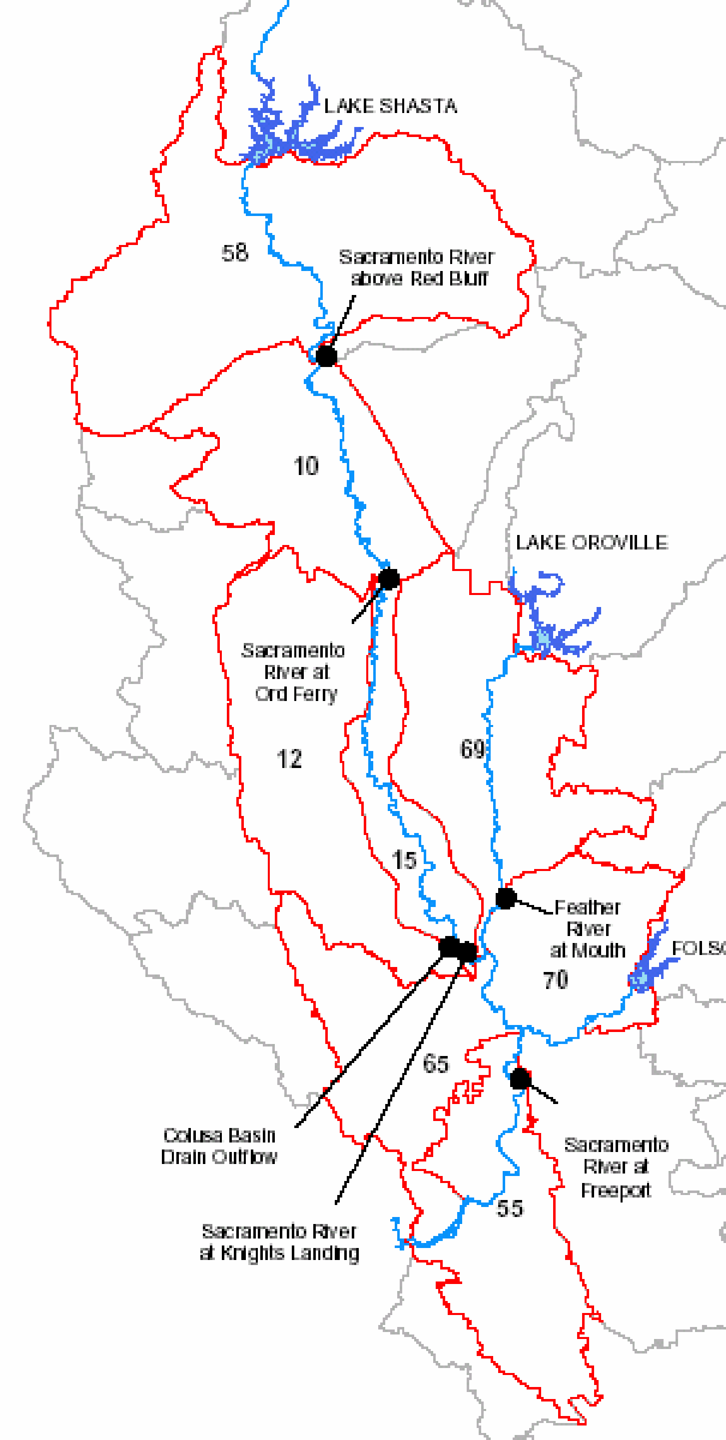
Area Represented by Calsim II Hydrology



- Represents entire drainage basin of the Sacramento-San Joaquin Delta
- Divided into 37 depletion study areas
- Valley floor DSAs (in color) modeled dynamically in Calsim II
  - large demands
  - deliveries integrated with CVP/SWP operations
- DSA represents spatial resolution of the model

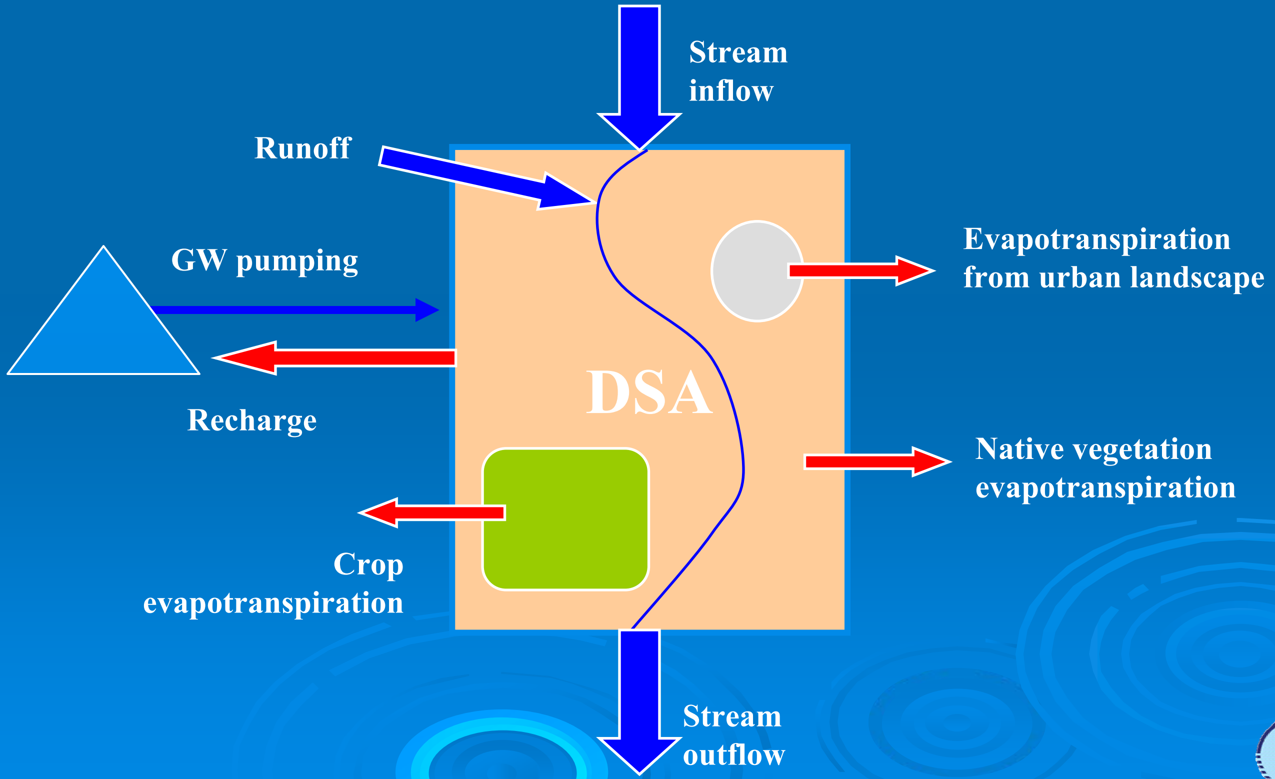
Water Supplies

- Inflows to major reservoirs
- Time series of inflows to each of the seven Valley floor DSAs
  - Represent direct runoff from precipitation and inflow from minor streams
  - Calculated as closure term in hydrologic mass balance on each DSA



Hydrologic Mass Balance

- Historical water supply = Historical Outflow - Historical Inflow
- Projected Water Supply = Historical Water Supply + Rainfall-Runoff Adjustment



Water Supply as a Calibration Term

- Water supply term contains all errors in mass balance
- Accounts for errors in:
  - stream flow record
  - estimated crop consumptive use of applied water
  - historical groundwater use
- For a historical land use Calsim II will exactly match historical stream flow if reservoir releases are fixed at their historical level and groundwater pumping and stream-aquifer interaction are fixed at their assumed historical level.
- During simulation, error at Delta may be introduced due to:
  - changes in land use from historical conditions
  - dynamic simulation of groundwater pumping
  - dynamic simulation of stream-aquifer interaction

Basin Efficiencies

- Basin efficiency used to translate crop consumptive use into a stream diversion demand
- Calculated from field measurements and water use budgets
- Current basin efficiency data require updating

Use of Groundwater

- Land-use base demands fully met
- Supply priorities for meeting demand
  - Minimum groundwater pumping
  - Surface water
    - up to the contract amount for project demand
    - and up to its availability for riparian demands.
  - Additional groundwater pumping for any unmet demand
- Minimum pumping volumes based on CVGSM[1] output

[1] *physically based integrated surface water groundwater model that has been calibrated to historical conditions*.

Stream-Aquifer Interaction

- Groundwater modeled as series of interconnected lumped parameter basins
- Stream-aquifer interaction dynamically calculated based on stream stage on groundwater elevation
- Calsim II groundwater model parameters calibrated against historical CVGSM simulation run

Rainfall-Runoff Adjustment

- Land use affects both direct runoff from precipitation and groundwater recharge
- Land use adjustment determined using CU model
- Additional flow = historical depletion of precipitation
  - projected depletion of precipitation
- Adjustment more significant during initial period of simulation
- No evaluation/validation

Summary

- The accretions and depletions between the project reservoirs and the Delta are calibration terms.
- Model groundwater pumping is based on the historical run of the CVGSM model that was calibrated to historical data.
- The Calsim groundwater model used for estimating stream-aquifer interaction is calibrated to the more spatially discrete CVGSM.

Summary

- Basin efficiencies determined from field data and water use budgets, but require updating.
- The hydrology adjustment to account for the impact of land-use change on rainfall-runoff has not been validated.
- Calibration or validation of diversions in Calsim II is difficult without increasing the patial resolution of the model.

Recommendations

- Following re-calibration of CVGSM, refine and re-calibrate Calsim II groundwater model
- Validate assumptions regarding land use change impacts on rainfall-runoff.
- Work with local water agencies to refine the spatial scale of Calsim II and calibrate/validate local projects operations through comparison of model output with historical data.

4. Hydrology Development and Ground Water Modeling

a. Short-Term Development Plan

by A. Draper

Strategic Goals

- Integrate the hydrology development with other statewide data collection and analysis efforts
- Provide a common approach for other planning models (Calsim II, IGSM, CALAG),
- Facilitate spatial and temporal aggregation and disaggregation, (modularity)
- Easy to update for changing land use conditions
- Facilitate the use of Calsim II to support other planning processes: e.g. water use efficiency program, and analysis of local management options

Current Hydrology

- Sacramento Valley
  - demands: land-use based
  - spatial resolution: regional scale (DSA)
  - groundwater: lumped parameter approach
- West-Side of San Joaquin Valley
  - demands: contract based
  - spatial resolution: contractor scale
  - groundwater: not represented
- East-Side of San Joaquin Valley (undergoing revision)
  - demands: land-use based
  - spatial resolution: district scale
  - groundwater: pumping and recharge arcs only

Proposed Future Priorities

- Surface Water Hydrology
  - Enhancement of the Sacramento Valley hydrology
  - Development of land-use based demands for the West-Side of the San Joaquin Valley
- Groundwater Hydrology
  - Refine, calibrate and evaluate lumped parameter groundwater model for the Sacramento and San Joaquin Valley
- Replacement of historical depletion analysis with rainfall-runoff modeling

b. Long-Term Development Plan

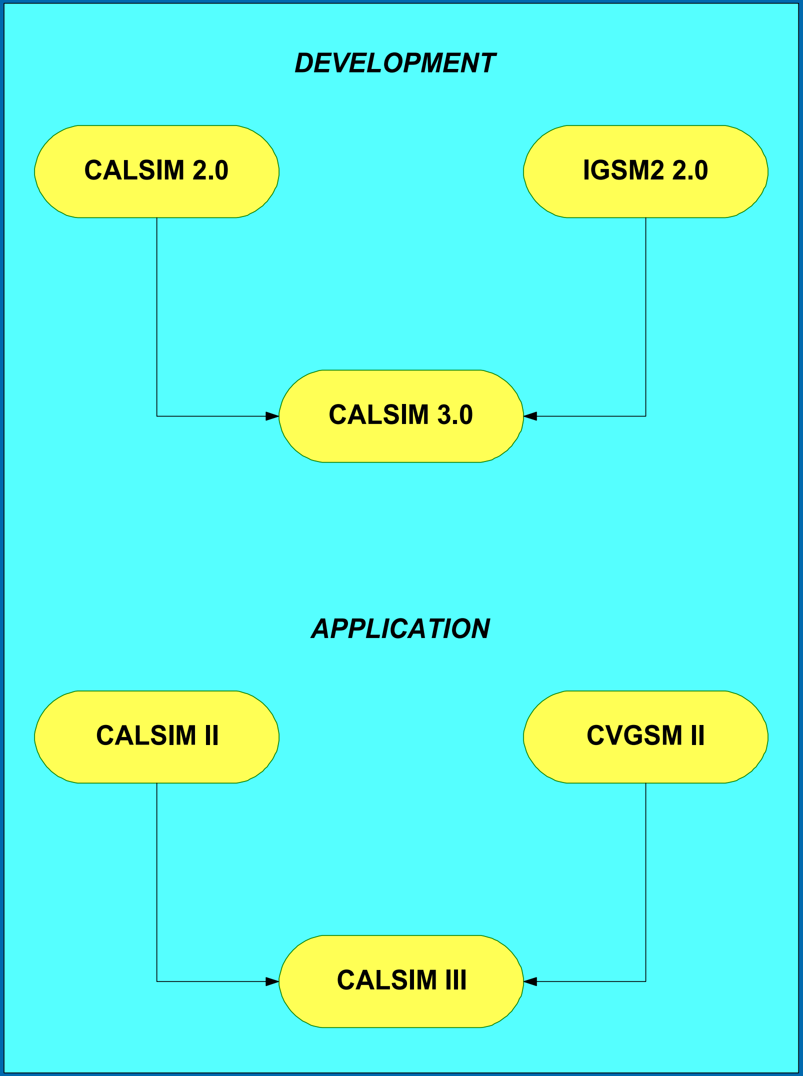
by T. Kadir

Objective

- To develop a new version of Calsim with improved simulation of surface water flow, ground water flow, and surface water – ground water interaction

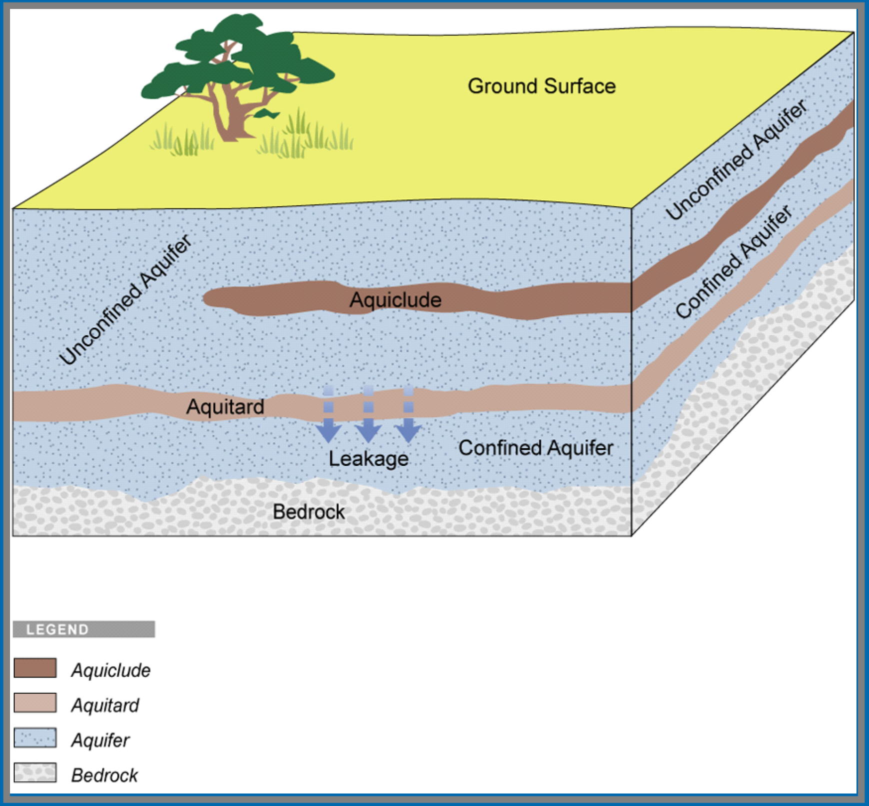
Engines and Applications

- Calsim 2.0 / Calsim-II
  - Simulation/Optimization (LP)
  - Allocation priorities, physical constraints, institutional constraints to operate SWP/CVP systems to meet in-basin and export demands
- IGSM2 v2.0 (Integrated Groundwater-Surface water Model) / CVGSM2 (Central Valley Groundwater-Surface water Model)
  - Calculating land use based demands, routing of water in streams, saturated/unsaturated zones, surface-water ground water interactions, balancing supply and demand
  - Physical representation of water resources system in the Sacramento, San-Joaquin, and Tulare basins

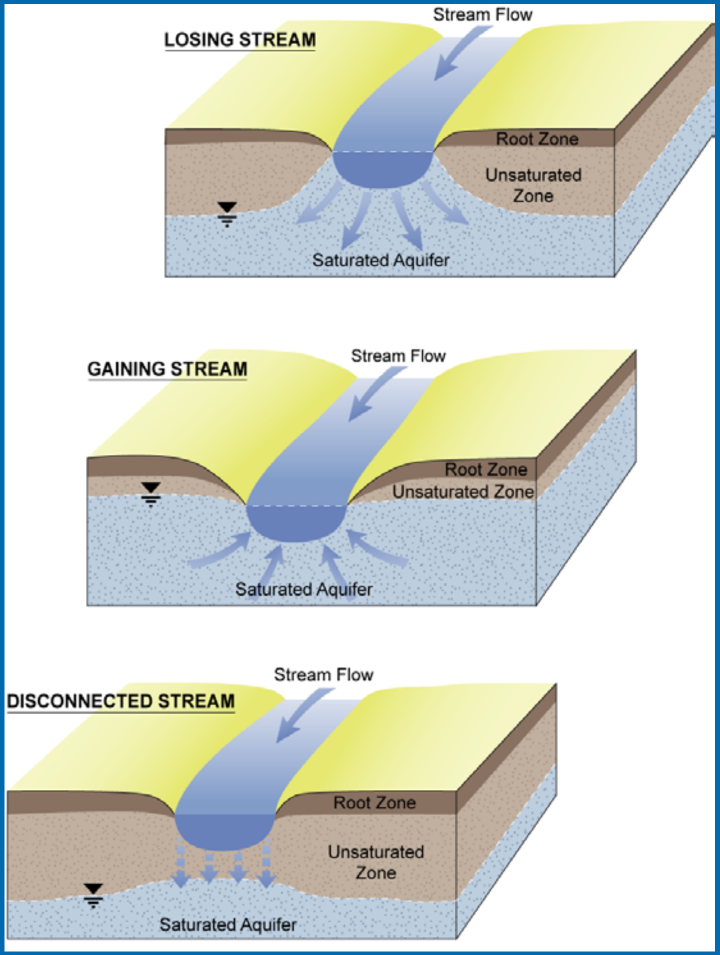


IGSM2 Modeling Components

Ground Water Flow

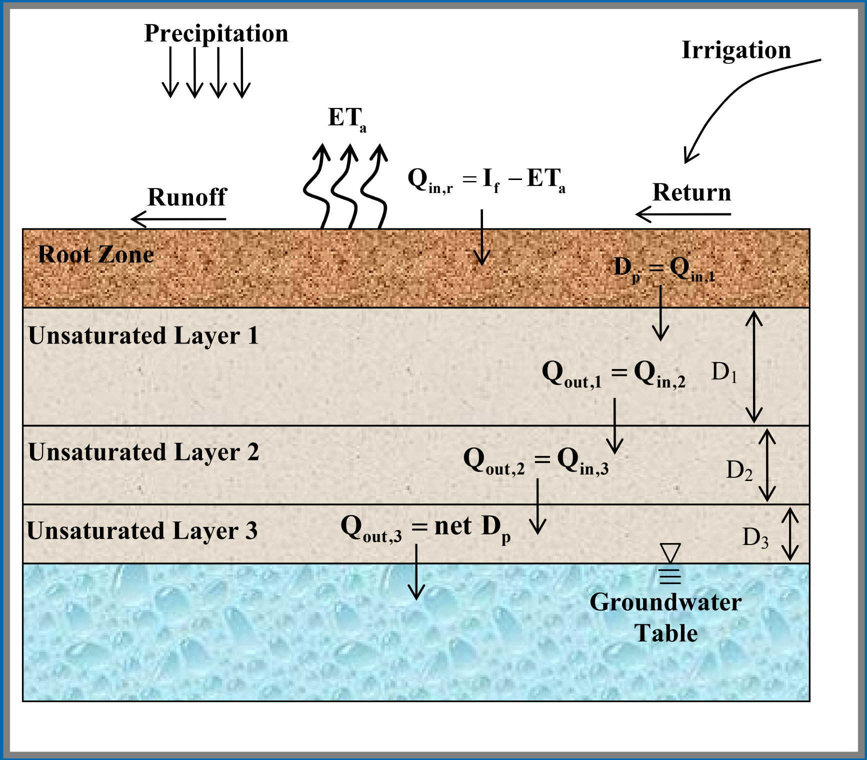


Stream Flow

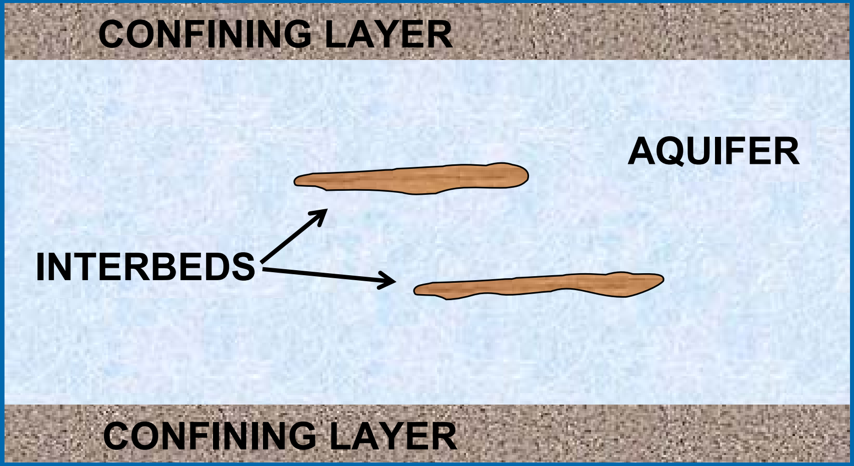


IGSM2 Modeling Components (cont.)

Soil Moisture Accounting

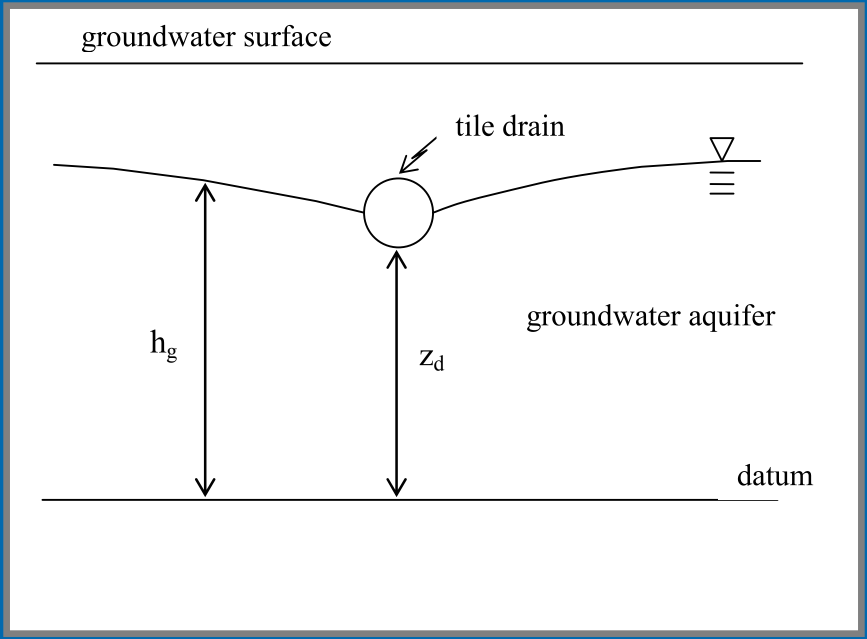


Land Subsidence

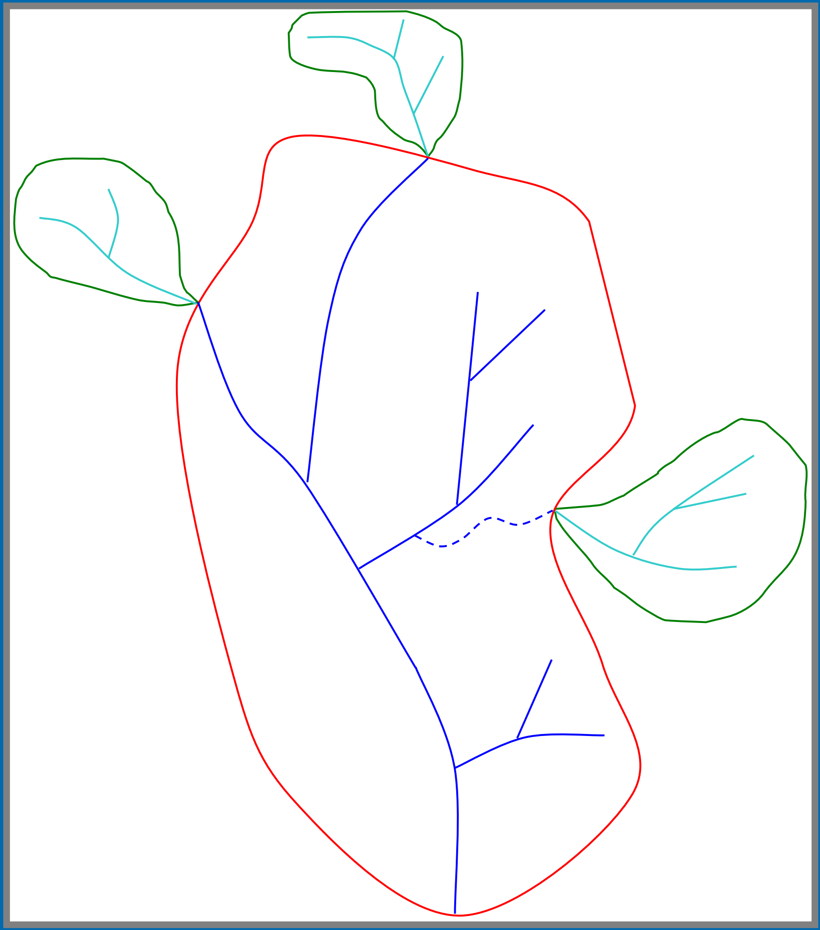


IGSM2 Modeling Components (cont.)

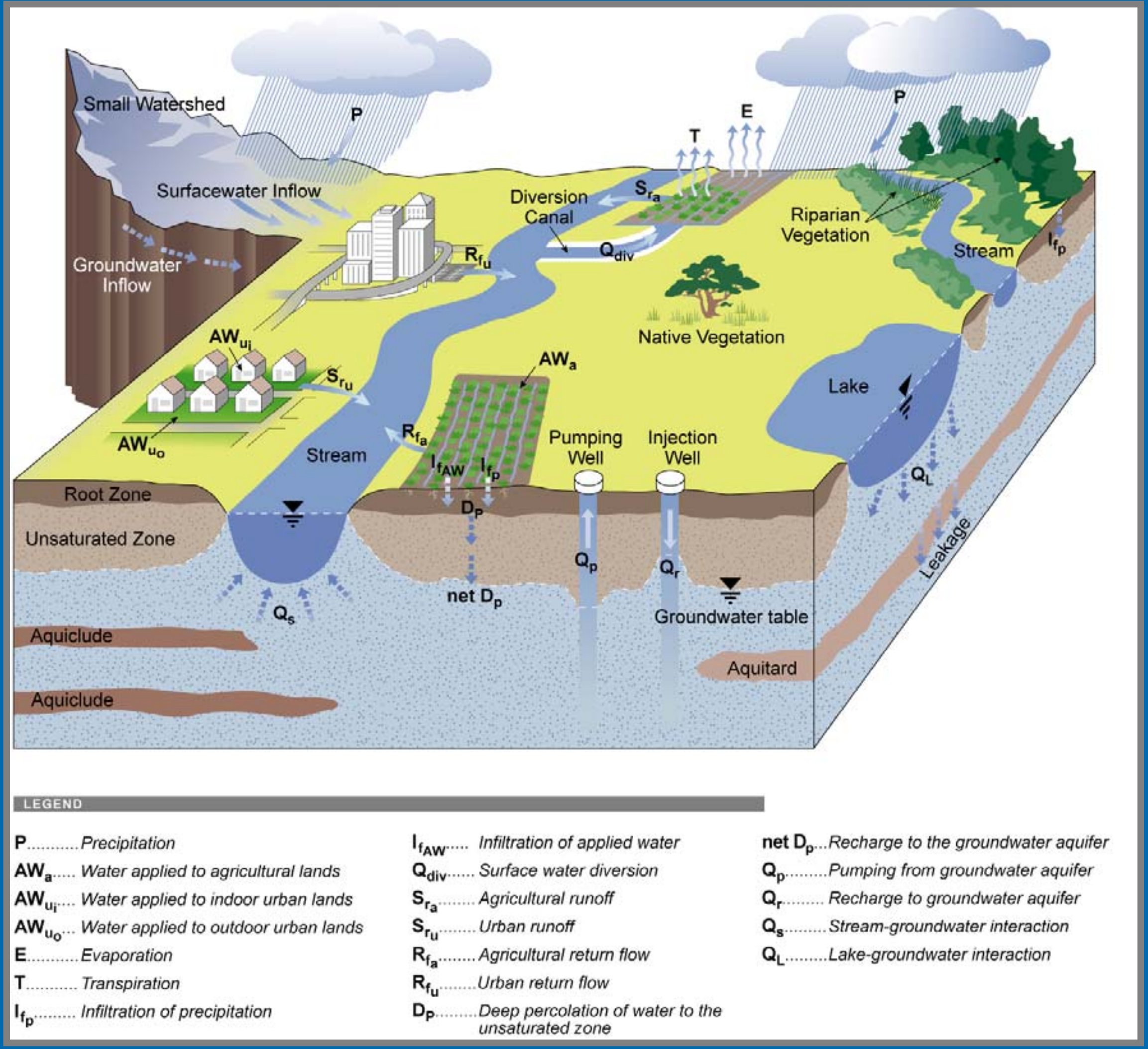
Tile Drainage



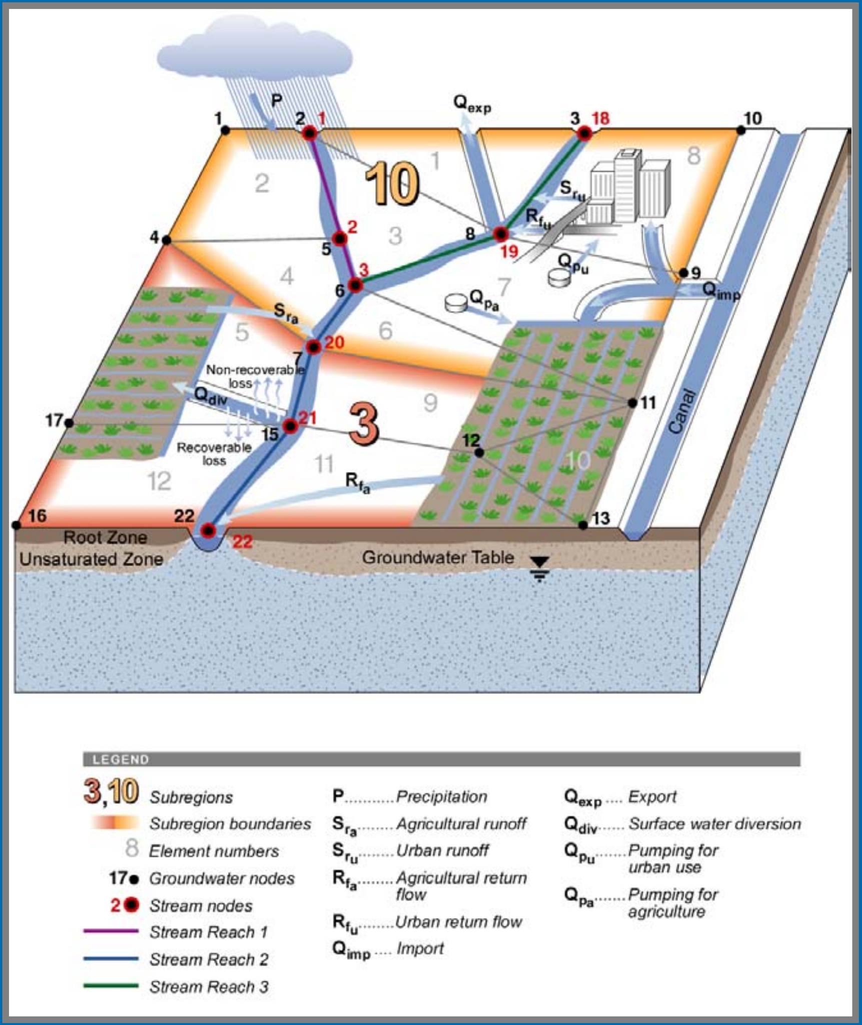
Small Watersheds



Features of IGSM2

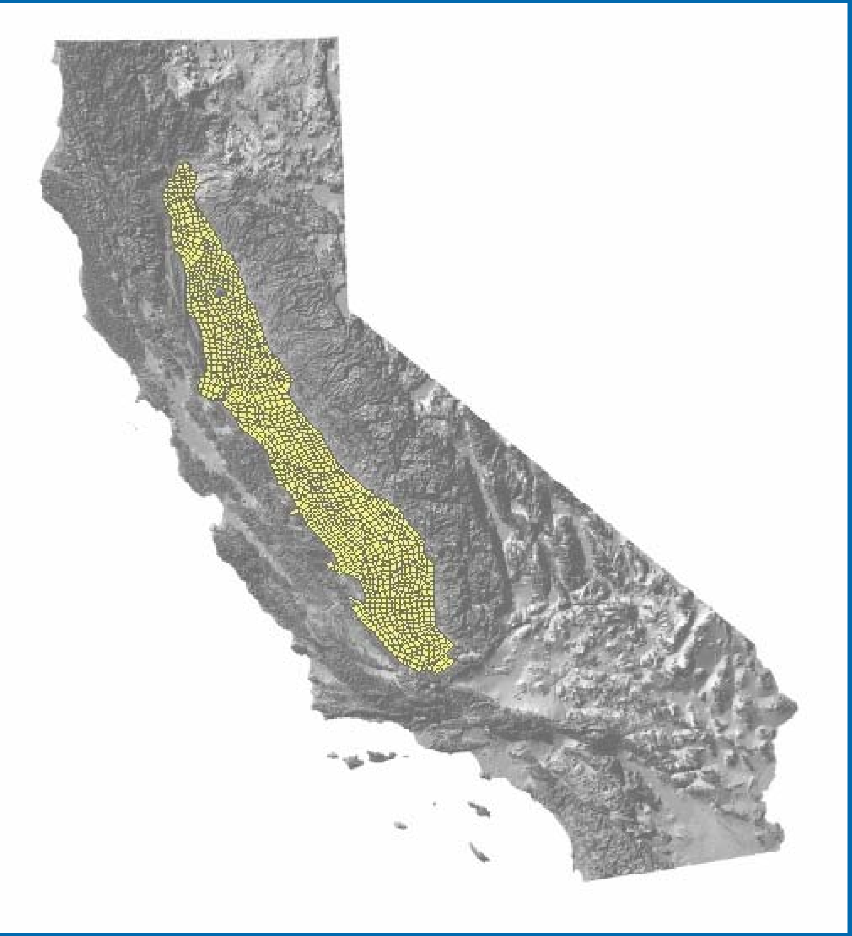


Agricultural and Urban Water Supply



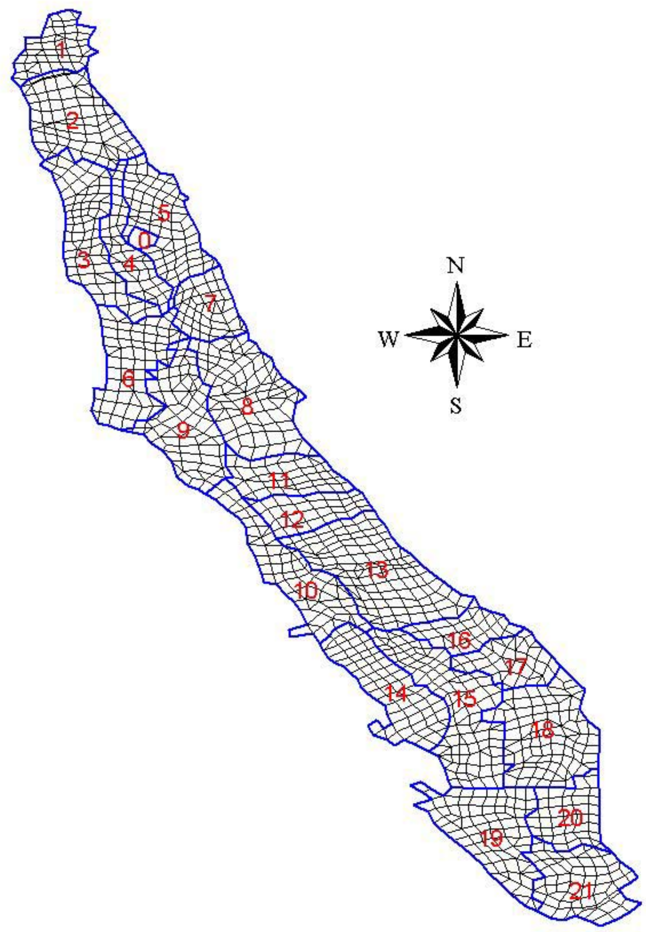
Extent of CVGSM Boundary

CVGSM2 Finite Element Grid



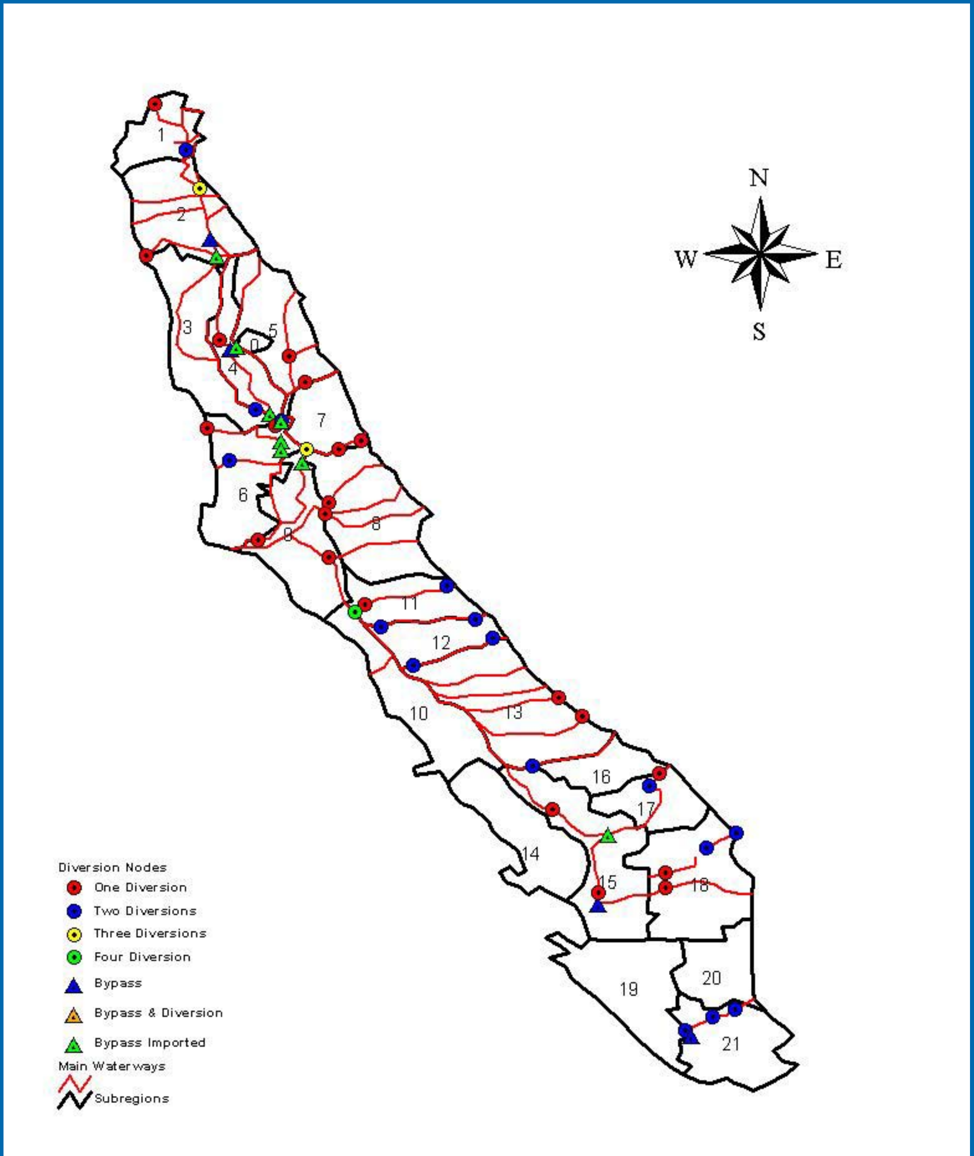
CVGSM Subregions & Element Configuration

- **APPROXIMATELY 20,000 MI^2**
- **3 AQUIFER LAYERS**
- **1393 NODAL POINTS**
- **1392 FINITE ELEMENTS**
- **21 SUBREGIONS**

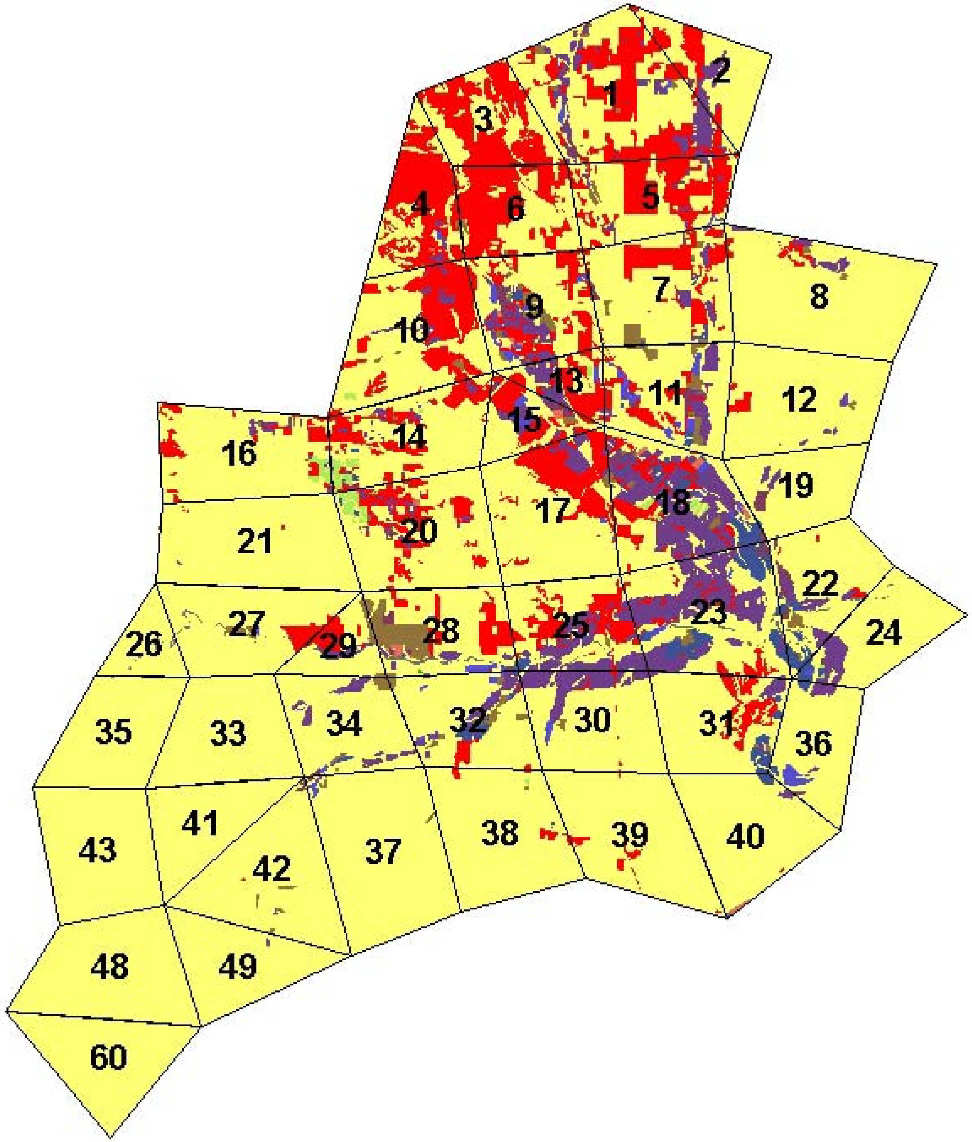


CVGSM Surface Water System

- 72 STREAM REACHES
- 121 SMALL WATERSHED INFLOWS
- 97 SURFACE WATER DIVERSIONS
- 2 LAKES
- 8 BYPASS CANALS



GIS Crop and Urban Data for DSA-58 & CVGSM2 Finite Element Grid



Benefits of Integrating Models

- Enhanced hydrology development
- Improved modeling of surface water flow, ground water flow and surface water – ground water interactions
- Capability for conjunctive use studies
- Extended simulation area to include Tulare basin

Conceptual Approaches for Integration of Models

- Indirect Approach
  - Communication through interface
- Direct Approach
  - Imbedding continuity equations as LP constraints
- Emulation Approach
  - Technological functions
  - ANN

Considerations in Integrating Models

- Theoretical
- Technical feasibility
- Accuracy
- Specific application and scale
- Computer technology
- Proprietary software
- Ease of use
- Technical Support

5. Summary and Conclusions

by T. Kadir

Summary

- Strategic Review identified many areas to extend model scope, improve data and documentation, and enhance software
- DWR/Reclamation support:
  - concept to broaden applicability beyond CVP/SWP systems
  - Modular approach
  - Additional modules (water transfers, conjunctive use, water conservation options, water quality, etc)
  - Extend spatial extent to include west side of San Joaquin valley and Tulare basin
  - Streamline development of alternate water supply and demand
  - Examine ways to better integrate Calsim II with other models (CVGSM2, CALAG, etc)
  - Enhance model credibility (documentation, hydrology, ground water, model testing, etc)
  - Improve Calsim II software (gui, post-processing utilities, reduced run times, automated weight setting, etc)
  - Engage local agencies

Conclusion

- “DWR and Reclamation believe that Calsim II is an adequate model for planning studies for new storage and conveyance facilities in the CVP & SWP systems. Many enhancements described in the Draft Response Plan, when properly implemented, will greatly improve the performance of Calsim II, thereby expanding the applicable scope of the model and enhancing the level of public acceptance. Sustained effort will be required to accomplish the planned enhancements. Periodic review and updates of the planned enhancements will also be part of the sustained effort.”